APPROVAL SHEET FOR SUSPENDED LOAD OPERATIONS

SLO-KSC-1998-002

TITLE SRB Frustum structure mate to Main Parachute Cluster Assembly

DOCUMENT NUMBER/TITLE Routing Operation Document System (RODS) Routing P/N 10123-M325-XXX.

PREPARED BY Mark A. Vazquez

DATE February 11, 1998

REQUIRED APPROVAL

CONTRACTOR	____ DESIGN	____ R & QA	____OPERATIONS	____SAFETY
NASA	____ DESIGN	____ R & QA	____OPERATIONS	____SAFETY

TYPE OR PRINT NAME	SIGNATURE	ORGN.	DATE
Mark A. Vazquez	Mark A. Vazquez	USBI-Safety	2/11/98
A. Uliberri		USBI-OPS DIR.	2-13-98
R. Elliot		USBI-ENG DIR.	2/13/98
B. Schmoyer		USBI-OS DIR.	2-13-98
R.C. Beagley		USBI-SF DIR.	2-13-98
D. Reed		USBI-VP	2-13-98
F. Anthony		SK-QAL	2-23-98
Malcolm Glenn	Malcolm Glenn	EI-C-A	2/24/98

CONTRACTOR DIRECTOR OF SAFETY

NASA SUSPENDED LOAD OPERATION
ANALYSIS/APPROVAL

NUMBER: SLO-KSC-1998-002
FEBRUARY 1998

OPERATION: SRB Frustum structure mate to Main Parachute Cluster Assembly

SUPPORTING DOCUMENTS: The associated operational procedures are as follows:

Routing Operation Document System (RODS) Routing Part Number (P/N) 10123-M328-XXX (Routing Code: 00N); Main Parachute, Ordnance Ring and Curtain Installation.
RODS Routing P/N FAC-0007 12P; 15-Ton Bridge Crane ARF High Bay, Monthly
RODS Routing P/N FAC-0007 13P; 15-Ton Bridge Crane ARF High Bay, Semi-Annual
RODS Routing P/N FAC-0007 14P; 15-Ton Bridge Crane ARF High Bay, Annual
RODS Routing P/N 10602-0094-101 12P; H77-0190-1 PML Sling Assembly, Frustum/Nose/Forward Assembly Handling

GENERAL DESCRIPTION: The operation allows individuals (one maximum at any one time) to be in the area of increased hazard directly under the suspended load for the operation involving the attachment and detachment of the handling sling to SRB Frustum/Nose Assembly while it is attached and suspended from the crane hook and also allow individuals (one person maximum at any one time) to pass directly under the handling sling to gain entry into the interior cavity of the Frustum structure for Main Parachute Installation at the KSC-ARF Facility (building L6-247).

Operations involving the suspended load of handling sling H77-0190-1 requires one person under the load to perform the following tasks:

a. To connect suspended handling sling H77-0190-1 cable assemblies in three locations to the Frustum attach points.

b. To disconnect suspended handling sling H77-0190-1 cable assemblies in three locations to the Frustum attach points.

c. To pass underneath suspended handling sling H77-0190-1 to gain access into Frustum structure interior for Main Parachute Installation.

d. To pass underneath suspended handling sling H77-0190-1 to egress from Frustum structure interior after Main Parachute Installation.

The individual is required to attach the handling sling to the Frustum as part of lifting operations during sub-assembly build-up. The individual will use a ladder to climb up and attach or detach the handling sling cable assemblies to or from the Frustum attachment points which are underneath the suspended handling sling envelope during operations. The individual is also required to gain entry and egress to the Frustum interior for Main Parachute installation and will pass directly underneath the suspended handling sling to enter the Frustum interior to accomplish this task. The operation is a unique assembly/build-up process due to the shape/configuration of the Frustum structure which exposes the individual beneath the suspended handling sling during attachment or detachment. The individual passing underneath the suspended load is part of an unique assembly/build-up process since connection is required by fastening the parachute cluster assembly to interior Frustum structure attachment points. Physical connection by the individual to accomplish these tasks is required for both handling sling-to-Frustum connection and also gaining entry access to Frustum interior for Main Parachute installation.

RATIONALE/ANALYSIS: The suspended load tasks comply with the NASA Alternate Safety Standard as follows:

Alternate Standard Requirement 1a: The Main Parachute installation to Frustum structure have been thoroughly evaluated and it has been determined that the operation cannot be practically/feasibly conducted without an individual passing or being beneath the handling sling. There are no procedural or operational means to completely eliminate the hazard of exposing an individual to a suspended load. In addition, it is not feasible to redesign the lifting/handling equipment to eliminate the requirement for an individual to work under a suspended load or to pass beneath an suspended load to gain entry to the Frustum interior for Main Parachute installation. An alternate Web Sling has been evaluated which reduces suspended load exposure; however; safe handling is compromised because the load is not stable when compared to the H77-190-1 handling sling.

Alternate Standard Requirement 1b: The possible use of a secondary support system to catch the load in the event of a crane failure has been reviewed and determined not to be feasible. Alternate methods of disconnecting and relocating the suspended handling sling to one side to enter the Frustum interior increases hazard/compromises safety to the individual by increasing connection frequency to detach and reconnect the suspended load handling sling cable assemblies. Designing secondary support equipment to catch the load would not be practical/feasible since the support stands needed would compromise and severely hinder operational procedures, would be difficult to manage and increase structural hazards while in close proximity to SRB Forward Skirt structures, Frustum structures and other GSE support equipment/fixtures located in the KSC-ARF high bay (building L6-247). Sufficient space is also not available for complete dedication to store/stage such support equipment without compromising current floor plan assembly flows, rendering them inefficient.

Alternate Standard Requirement 1c: The maximum number of personnel permitted beneath the suspended load at any one time is one (1). The maximum number of personnel permitted to pass beneath the suspended load at any one time is one (1).

Alternate Standard Requirement 1d: Exposure time/duration under suspended load is approximately 90 seconds for attachment/detachment of three handling sling cable assemblies to the Frustum and passing beneath the suspended load to gain entry to or egress from the Frustum interior takes approximately 5 seconds.

Alternate Standard Requirement 4: Operational requirements are included in the approved released RODS Routings which will be on-site for inspection. The operating procedures include warnings and precautions to minimize the exposure of personnel to suspended loads.

Alternate Standard Requirement 6: The suspended load operations covered by this report are performed using one of the ARF facility high bay (building L6-247) 15-Ton bridge cranes. The cranes are tested, inspected, maintained and operated in accordance with NASA Safety Standard for Lifting Devices and Equipment, NSS/GO-1740.9. The crane are designed in accordance with the CMAA 70 specification.

The cranes are proof loaded one time at 125% of rated load and load tested annually at 100% of rated load. The cranes are subject to a monthly, semi-annual and annual preventive maintenance program schedule as outlined in RODS Routings P/N's FAC-0007 12P, FAC-0007 13P and FAC-0007 14P. The wire ropes and hook are inspected monthly for discrepancies. Nondestructive testing of the crane hook is performed annually.

The Frustum Handling sling H77-0190-1 is subjected to an annual preventive maintenance program schedule per RODS Routing P/N 10602-0094-101 12P. The handling sling is proof loaded tested to 54,100 - 56,800 pounds annually with non-destructive tests performed on all critical welds of the handling sling weldment. The Frustum handling sling H77-0190-1 weighs approximately 640 pounds. The Handling sling is designed with a safety factor of 5 to 1 against failure (ultimate strength) and 3 to 1 against yield strength. The handling sling is rated at 23,000 pounds working load. The handling sling's upper wire ropes are production load tested one time to 40% ultimate strength loaded or 31,840 - 33,430 pounds each (load test is applied three times). The handling sling's cable wire drop ropes are production load tested one time to 40% ultimate strength loaded or 23,520 - 24,690 pounds each (load test is applied three times). The crane is loaded to approximately 640 pounds, the weight of the handling sling, or **2.8%** of rated capacity during connection/disconnection to the Frustum. The crane is loaded to approximately 6,640 pounds, the weight of the sling and the Frustum subassembly, or **22.0%** of its rated capacity during ingress to/egress from the Frustum.

The 15-Ton hoisting cranes meet a **"7 to 1"** design load safety factor for the main hoist wire rope, sheaves, equalizer bar, and block and hook (based on ultimate strength).

Alternate Standard Requirement 7: Although a formal Failure Modes and Effects/Analysis (FMEA) has not been performed for the ARF facility high bay (building L6-247) two 15-Ton bridge cranes, the crane hoisting systems have been reviewed to determine if there are mechanical or electrical single point failure points excluding the cranes structure and passive items (i.e., hook, load block, wire rope, sheaves and rope drum).

The cranes have two independent dual-holding braking systems; 1.) a calibrated overspeed air caliper braking system located downstream of the hoist gearbox and 2.) an electrically operated two-shoe brake system (standard for industry). The General Electric Silicon Controlled Rectification (GE SCR) Maxspeed Hoist Controller affords precision fail safe operation by providing electrical protection of the A/C power supply to the electronic components. Loss of A/C power, loss of control power, loss of motor field or D-C motor overload provides for the power to be removed from the motor and both braking systems to be applied. The GE SCR controller also provides stepless speed control which permits jolt-free operation and functions in normal, creep, and "load-float" modes. The crane systems also feature a crane emergency stop button, monitored during hoisting operations by a certified operator and when initiated, simultaneously disconnects the crane's electrical power (i.e., the main circuit breaker) and sets/engages the dual-braking systems. The hoist is equipped with a geared upper limit switch, a geared lower limit switch and a paddle upper limit switch.

Mechanically, at least two failures are required to cause the load to drop. As stated, the electrical system is designed to fail safe (stop). Based on the mechanical and electrical design of the cranes hoisting system, there are no single failure points in the ARF facility high bay (building L6-247) two 15-Ton bridge cranes that will cause the load to drop. The use of high quality, reliable components and a comprehensive preventive maintenance, inspection and test program, including preoperational checks, ensures that the two crane systems operate properly.

Alternate Standard Requirement 8: Visual inspections for cracks or other signs of damage or anomalies are performed on the cranes, the H77-0190-1 handling sling equipment and crane functional checks are performed prior to each operation in accordance with NSS/GO-1740.9.

Alternate Standard Requirement 9: The crane operators and mechanical technicians possess current certifications for operations involving Frustum-to-sling attachment/detachment and to gain entry and egress to the Frustum interior while the sling is suspended overhead. Crane operators shall all complete and pass crane certification training course No. TG-340-KSC and OJT-330-USB (certified per NSS/GO-1740.9). A trained and certified crane operator shall remain at the crane controls while personnel are under the load.

Alternate Standard Requirement 10: Appropriate safety control areas are established before initiating operations. Only a minimum number of personnel will be allowed in this area and will be identified as such in RODS Routings prior to entering the area. Operations supervision/task leader is responsible for ensuring the control area is maintained and the manloading requirements are met. Safety personnel will be on-site to monitor operation.

Alternate Standard Requirement 11: A pretask briefing and walkdown are conducted prior to the lift to ensure all systems and personnel are ready to support. Upon loss of voice/radio/visual contact, the operation shall stop immediately, personnel shall clear the hazardous area and the load shall be safed. Operation shall not continue until voice/radio/visual contact is restored. All participants are instructed on their specific tasks and warned of the hazards involved. Verifications of current proof load certifications shall be made on all associated lifting equipment prior to start of operations.

Alternate Standard Requirement 12: Personnel working beneath the suspended load are in voice/radio/visual contact with the crane operator and/or task leader. At any time during the operation anyone can call a safety hold if they see a discrepancy. The crane operator will have full visual contact with the load throughout the operation.

Alternate Standard Requirement 13: The task leader and crane operator are in visual contact with personnel beneath the suspended load throughout the operation.

APPROVAL: DATE:

Joel R. Reynolds 2/24/98

Joel R. Reynolds
Director, Safety Assurance
Kennedy Space Center